

Read Chapter 2, answer the following problems, and indicate with whom you worked: _____.

- (1) Do problems 1.1, 1.5, 1.6, and 1.10 in Bard and Faulkner (B&F).
- (2) Using the CRC Standard Reduction Potentials table, and the lecture notes for the reference electrode potentials vs. SHE, plot on a vertical line (with negative toward the top) the standard reduction potentials for H^+ , H_2O_2 , and O_2 (both of them) in acidic conditions versus the following references:
 - a. SHE
 - b. SCE
 - c. Ag/AgCl (KCl saturated)
 - d. absolute (vacuum) scale
 - e. “ground scale;” assume these were measured using a classical three-electrode potentiostat; include the potential for SHE for each of the four half reactions (i.e. reduction of H^+ , H_2O_2 , and O_2).
- (3) Integral to the function of a classical three-electrode potentiostat are three different types of op(eration)al amp(lifier)s each with feedback. With this in mind, answer the following.
 - a. What is the gain when $R_{\text{feedback}} = 100 \text{ k}\Omega$ and $R = 100 \text{ }\Omega$?
 - i. Then, explain where the power comes from that results in this gain in potential.
 - b. The voltage follower at the RE has a gain of 1. Why, then, do we use it?
 - c. How, and where, is the current that flows between the WE and CE measured?
 - d. Like in the lecture notes, draw a three-electrode J - E curve and label the predominant redox processes that occur for an aqueous solution of deaerated HCl at standard state.
 - i. Between which two electrodes does the majority of the current flow?
 - ii. Between which two electrodes is the potential, E , measured?
 - iii. On this plot, draw the response from a counter electrode made from the same material as the WE but whose geometric surface area is 10 times larger.
 - iv. Explain the rationale for choosing the location, size, and material of the CE.
 - e. Now consider a solution that consists of HCl and H_2 at standard state. If the size and material of the CE is identical to that of the WE, and the RE (SHE) is placed exactly halfway between the WE and CE, draw the response of the WE (versus the RE) and CE (versus the RE) when the potential is swept in the negative direction starting at the open-circuit condition.
 - i. Would a Pt wire have made for a good quasireference electrode in place of the RE (SHE)? Why or why not?
- (4) In Forman, Chen, Chakthranont, and Jaramillo, *Chemistry of Materials*, 2014, 26, 958 (see class website), the electrochemically active surface area of various WEs was indirectly calculated using the data shown in Figure 3. Based on this, answer the following:
 - a. For Figure 3a, why did the authors choose such a narrow scan window?
 - i. At approximately what negative potential would you expect a faradaic reaction to occur? And, what faradaic reaction is likely to occur there?
 - b. Using the data at the three fastest scan rates in Figure 3b, calculate the average capacitance ($\text{C V}^{-1} \text{ cm}^{-2}$) for each high-surface-area electrode. (Average three values per electrode, for four electrodes.)
 - c. How did the authors determine the roughness factor (RF) in Figure 3c?